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TUPOLEV: ITS "MOUSTACHES" WERE TOO LONG AND FRAGILE

Dominique Walter

Translation of "Tupolev: ses 'moustaches' étaient trop longues et fragiles," Science et Vie, August 1973, pp. 44-47

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16. Abstract

The present article describes the recent Tupolev tragedy at Le Bourget. When the Tupolev lost its "moustaches," which increased by 20% its general lift at low speeds, the aerodynamic center moved too far back under the delta wing and the aircraft began to break up and dive.

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Wishing to improve their performances, Soviet designers /44* came up against the formidable problems posed by the forward auxiliary wings, the famous "moustaches." They were in the process of solving them when tragedy struck.

Any effort to analyze the Tupolev drama requires concentration on certain points to the exclusion of adventitious considerations. Let us therefore forget that the new version of the Tupolev 144 presented at Le Bourget was the third of the ten preproduction prototypes now being test-flown and that it resembled the Concorde closely.

Let us also forget the climate of emulation which prevailed at Le Bourget and which led certain entrants to go as far as the point of no return.

Let us also forget Captain Mikhail Koslov's refusal to allow anyone on board other than his own crew and that André Turcat was not in on the "trip," whether by his own doing or not. Let us forget the unacceptable theory of sabotage, which is ruled out by the security measures taken on the ground and, finally, let us forget the discretion of the boards of inquiry confronted with a problem of the first magnitude.

Let us note in the first place that this Tu-144 was the first to be equipped with "moustaches." These are stabilizing ailerons -- retractable surfaces deployed at low speeds -- whose purpose it is to assure the aircraft's better stabilization at low speeds, i.e., when taking off, approaching or landing.

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*Numbers in the margin indicate pagination in the foreign text.

Mr. Tupolev, Jr., surrounded by his technicians, has stated, and rightly so, that when these "moustaches" are placed forward, they lead to a gain of 15% in the aircraft's general fineness. The fineness is the ratio of the lifting capacity, which is the force perpendicular to the direction of the velocity and which assures the aircraft's lift, to the drag, which is defined as air resistance to forward motion.

This gain of 15% in fineness was expressed in a gain of 20% in the total lifting capacity. This spectacular improvement permitted the Tu-144 to achieve take-off, approach and landing speeds that were considerably lower than those of the Concorde and therefore gave it access to all existing airports. /46

Now we are in the deep waters of pure technology. Here is what we learned from an expert, Mr. Marcel Chabonat, long-time Director of the Eiffel Aerodynamics Laboratory. There have already been aircraft with a forward wing; they are called "canard" aircraft.

From Santos-Dumont, the Wright brothers and Voisin to the quickly abandoned North American Mach 3 B-70 bomber "Valkyrie," they all suffered from problems connected with this auxiliary wing. The reason for this might be said to be that the "canard" wing acts in front of the aircraft's center of gravity while the classic rear elevator acts at the other end; should this "canard" wing, which does lead to additional lift in normal flight, be the first to stall, this would cause a loss of total lift. This complex problem is illustrated by our diagrams.

But also to be brought into the picture is the difference between an aircraft's lift and its maneuverability.

In order to obtain maneuverability, as well as safety at large angles, the main wing must "stall," i.e., lose a part of its lift

(at low speeds), before the "canard" surface. Hitherto, the contrary was felt to be the case, but the fact is that the main wing must be the first to stall if the pilot is to keep longitudinal control of the aircraft, which does not happen if the "canard" surface is the first to stall, even if, in this case, the main wing keeps all of its lift.

Moreover, the shape and the aspect ratio of the "canard" surface must be in keeping with the main wing. This delicate problem has been perfectly solved only by the Swedish Saab 37 fighter "Viggen" (we must also mention the moderate success of the "Milan" Dassault). It is known that a wing with a large aspect ratio leads to better fineness. This is no doubt the reason that the quadruple-slot "moustaches" of the Tu-144 had a large aspect ratio.

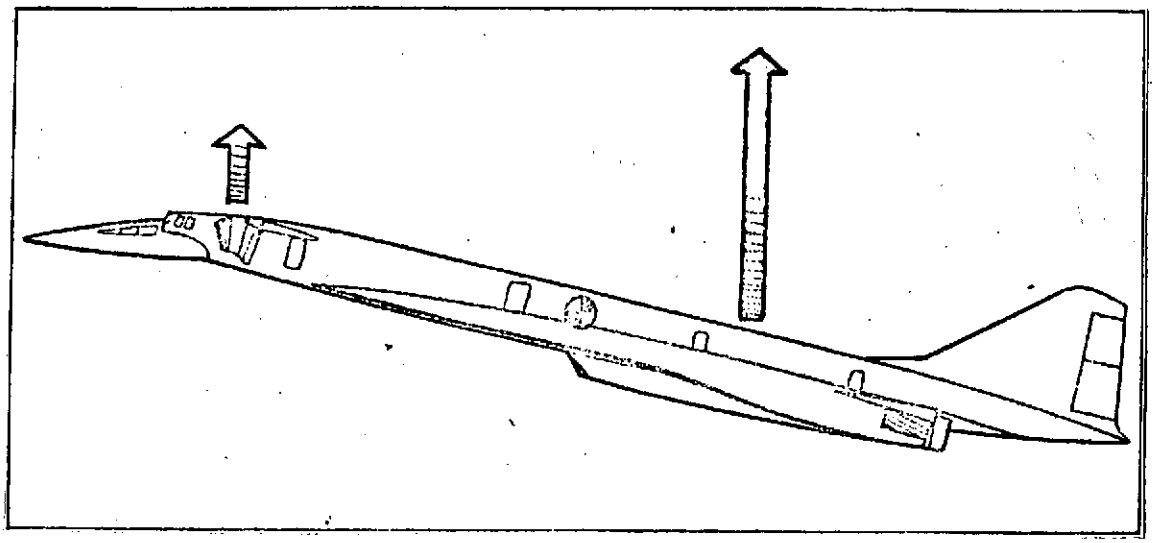
But it turns out that this large aspect ratio is only one side of the coin: when "stalling" does take place it is brutal, and this point has got to be kept in mind. Just as we must keep in mind the following fact: when the "moustaches" are placed in front of the delta or pointed wing, as was the case for the Tu-144, stalling of this "canard" wing causes the main wing to stall, which confirms the above-mentioned requirement: the main wing must be the first to stall.

In order to grasp this fact clearly, you must know that the "moustaches" cause a deflection -- a change in direction of the air-streams -- that decreases the relative incidence of the main wing, i.e., the force with which it "cuts" the air. When the "moustaches" stall before the main wing, this deflection vanishes instantly. All of a sudden the lift of the main wing increases. The aerodynamic center is shifted toward the rear, which causes a "diving" moment. This gets added to the loss of lift which is due precisely to the stalling of the "moustaches" inasmuch as the main wing is then the only one to support the aircraft. This leads to a loss of lift that affects the entire aircraft.

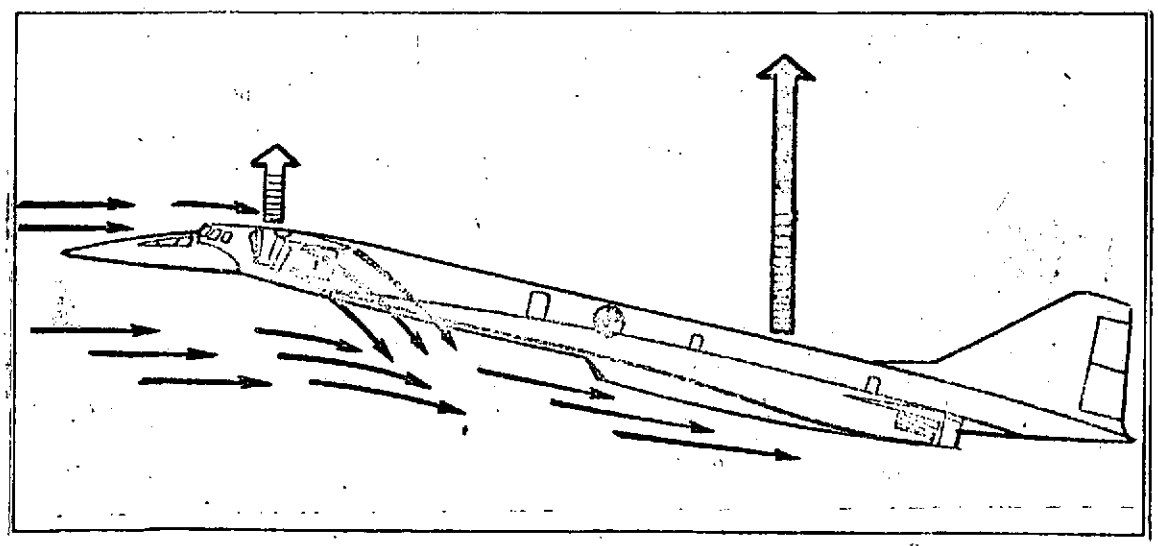
Let us now review the Tu-144 tragedy. After landing and taking off again it executes a very sharp turn, i.e., under a load factor that is greater than normal. Whether it be a question of a turn or a rapid climb, this load factor, which is expressed in thrusts on the surface of the aircraft, affects all of its points. It was incident to this very sharp turn -- facilitated, incidentally, by the "moustaches" -- that some parts broke away. Now then, at the end of the runway tubular pins were found that could only have been components of the "moustaches." Mr. Chabonat had the right idea: the aircraft must have lost a part of its lift, even if, during its climb, the "moustaches" seemed to be present. Present they were, but not completely so.

Under this enormous load factor the aircraft went into a spectacular climb. It disappeared into the clouds and reappeared in a dive. Everything got worse: the loss of speed exerted such an effort on the structural elements that the aircraft lost half of its left wing. This caused the fuel feed lines to break up, spilling fuel into the reactor pods on that side. This led to the first fire. With its left wing gone, the aircraft went into a roll on the same side; this caused the vertical stabilizer to break up and disappear. Appealing to whatever was left of his controls, the pilot "squeezed the last drop" out of his control stick and, in doing so, caused the right wing to be lost and the fuselage to break up ....

In normal flight, the "moustaches" of the Tu-144 give it access to all airports. /45



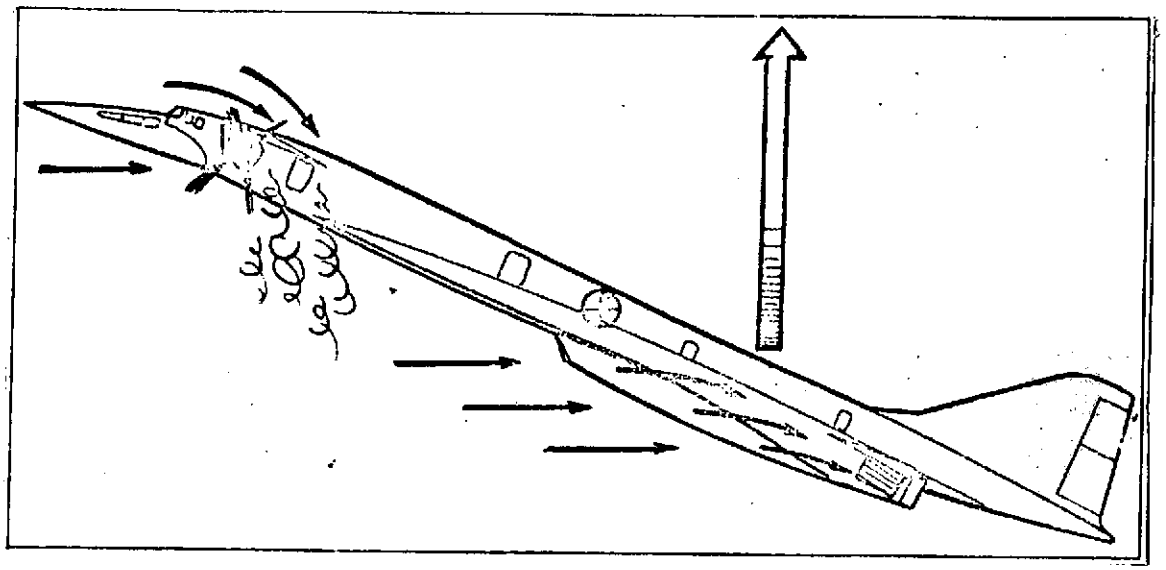
Appearing on the Tu-144 presented at Le Bourget this year, one of the ten preproduction prototypes now being test-flown, the "moustaches" that caused such a stir were of unquestionable utility: they increased by 20% the aircraft's general lift when approaching, landing or taking off, i.e., at low speeds. By virtue of this fact, they gave this masterpiece of Soviet aeronautics access to airports that are not equipped to handle supersonic aircraft. The arrows in our drawing give a proportionate idea of the vertical thrust or "lift" of the "moustaches" and of the main delta or pointed wing ...



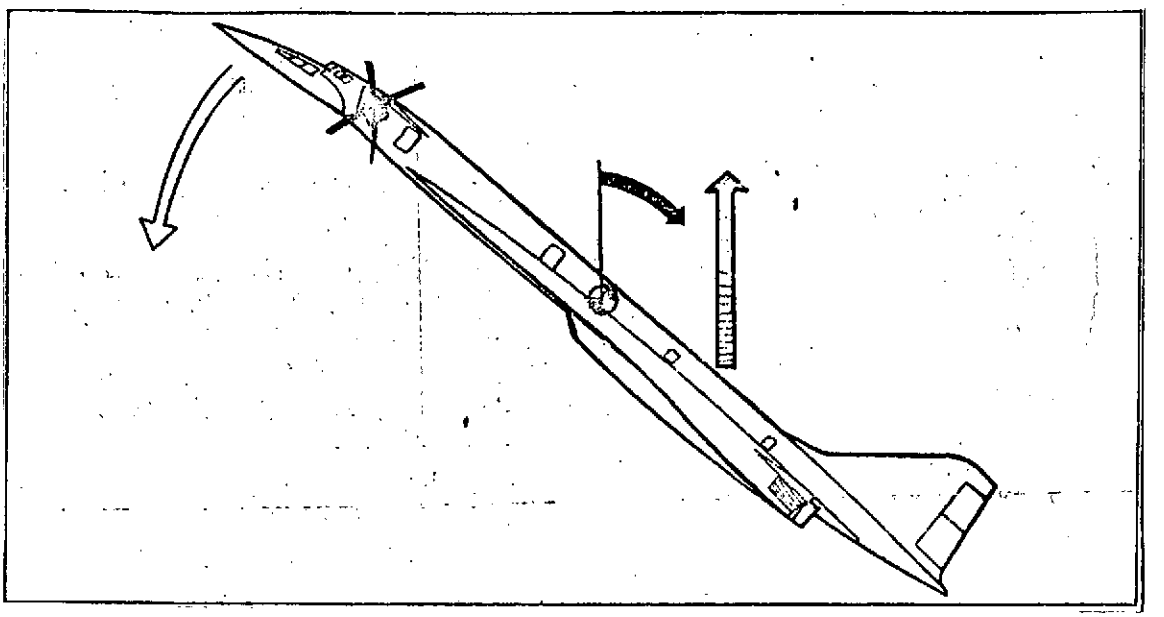
...Moreover, the moustaches had quadruple slots, a fact which considerably increased their lifting capacity. By deflecting the [cont'd. on following page]

streamlines ahead, they reduced the force with which the edges of the main wing attacked the air. In doing so, however, they also obliged the aircraft to fly with its nose somewhat up in its attempt to recover its complete initial lift.

What happened: Losing its "moustaches" in flight, the aircraft "stalled" and then dived. /47



It may be that the test flights carried out at Le Bourget before the tragedy, subjected the Tu-144 to very strong thrusts, perhaps too strong for the "moustaches." When the moustaches were lost in flight or "stalled," the aircraft was deprived of their support. In the absence of deflection, the center of thrust moves on to a point under the main wing and the trouble starts: if the wings have a large angle of incidence when the "moustaches" are lost, the aerodynamic center moves much farther back with a delta wing than with a subsonic wing...



...When this happens, instead of diving slightly, as would be the case if the wings had an acceptable angle of incidence after the "moustaches" stalled, the aircraft pulls its nose up abruptly -- unless disequilibrium is so strong that it dives vertically. This is called self-stalling: the wings no longer support the aircraft, which becomes uncontrollable, breaks up and falls.